11 8

--~~34~~. The rotary pump of claim ~~28~~, further comprising a fastening nut threaded onto said bolt head of the rotor fastening bolt against the outer end of said hollow rotor drive shaft.--

a'

15 12

--~~35~~. The rotary pump of claim ~~29~~, further comprising a fastening nut threaded onto said bolt head of the rotor fastening bolt against the outer end of said hollow rotor drive shaft.--

REMARKS

Claims 21-35 are in the application. The claims were changed to provide a stylistic improvement to the originally filed claims. Claims 28-35 are merely stylistically improved versions of original claims 8-15 which were deemed to be allowable. Claims 23-26 are stylistically improved versions of claims 3-6 which were allowable if rewritten in independent form.

Claims 16-20 are withdrawn from consideration and are retained merely for a possible divisional.

Enclosed herewith is a substitute disclosure including all the stylistic changes that were necessary to the original disclosure. Also enclosed is a redlined copy showing the changes that were made in the original disclosure. No new matter was added.

Whatever the primary references Morita or Barton disclose, the combination of either of them with Wedler is respectfully submitted to fail to make the claims obvious.

The present invention relates to a rotary pump having a cylindrical

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transmission coupling (see Fig. 2) having an operating space therein for the bolt head of the rotor fastening bolt. The cylindrical transmission coupling is coupled with the extended drive shaft portion for rotation therewith. These features cannot be seen or even remotely perceived from Wedler (U.S. patent No. 3,962,933).

That reference merely discloses a multistage speed reduction gear 5 which is different in its operation from the transmission coupling of claim 1. In Wedler the power and the torque from the motor 1 is transmitted to the hollow shaft 21 and shaft 16 inside the gear casing 18 and are further transmitted through the gears 22, 23 to the output shaft 24 finally to the drive generator and/or other auxiliary equipment (column 3, ls. 39-40) and through the gear 19 to the propellor shaft (column 5, line 50). Thus the coupling of Wedler is a speed reduction gear which differs substantially from the transmission coupling of claim 20.

Enclosed herewith are Figs. 10 and 11 with the proposed additional legend shown thereon in red.

In view of the foregoing, reconsideration of the rejection, and the allowance of claims 20-35 are respectfully urged.

Respectfully submitted

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It is hereby certified that this is being mailed, as addressed above, on June 19, 2001

Cynthia A. Pilato

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~~ROTARY PUMP 0673-119P\~~ **[0673-119]**

~~\BACKGROUND OF THE INVENTION\~~ [Rotary Pump]

Field of the Invention

The present invention relates to a rotary pump suitable for transporting liquid foods.

~~\Description of the Related Art\~~ **[Background]**

~~\In a rotary pump of the type set forth above, the recent prior art has been\~~ **[The most recent prior art in connection with rotary pumps is]** disclosed in commonly owned U. S. Patent No. 5,370,514, ~~\issued to Morita et al.\~~ **[to Morita et al.]**

~~\Since the present invention has some common structures with the above-identified commonly owned prior art, the construction of the prior art will be\~~ **[The prior art structure is]** discussed hereinafter in detail ~~\in order\~~ to facilitate clear understanding **[of the improvements]** of the present invention.

Figs. 10 and 11 show the commonly owned prior ~~\art. In these drawings, the reference numerals 1A and 1B denotes rotors. From each of rotors 1A and 1B,\~~ **[art. In these drawings, rotors 1A and 1B from]** a short rotor shaft 2 is provided from the central portion of one end surface ~~\thereof.\~~ **[thereof.]** A threaded bore 3 is coaxially formed from the end surface of the rotor shaft ~~\2.\~~ **[2.]** A pumping segment 4 is integrally formed on the outer peripheral portion of each rotor 1A and 1B.

~~\The reference numeral 6 denotes a pump casing. The\~~ **[A]** pump casing 6 includes a main casing defining a concave pumping chamber 7 loosely accommodating the pumping segments 4 or revolution therein and formed with a suction port 8 and a discharge port 9, and a casing cover 11 detachably attached on ~~\the\~~ **[a]** main casing 10 flush with the end surface of each rotor 1A and 1B by ~~\means of\~~ bolts and nuts.

~~\The reference numeral\~~ **[Hollow rotor drive shafts]** 12A and 12B ~~\denote hollow rotor drive shafts\~~ **[are]** provided corresponding to the rotors 1A and ~~\1B.\~~ **[1B.]** The rotor drive shaft **[12]** is supported by ~~\means of\~~ a bearing 14 within a gearbox 13 for the drive shaft**[,]** for rotation and **[for]** restricting movement in an axial ~~\direction. The~~

~~reference numeral 15 denotes a~~ **[direction. A]** rotor fastening bolt **[15 is]** inserted through a hollow portion of each of the hollow rotor drive shafts 12A and 12B from one end to the other ~~end.~~ **[end.]** A bolt head 15a of the rotor fastening bolt 15 is engaged with one end surface **[of the]** rotor ~~drive shaft~~ **[fastening bolt]** 15.

A hollow portion 16a at the tip end of each rotor drive shaft 12A and 12B is externally engaged with the rotor shaft 2 of each rotor 1A and ~~1B.~~ **[1B.]** In conjunction therewith, a threaded portion 15b at the tip end of the rotor fastening bolt 15 is threadingly engaged with the threaded bore 3 of the rotor shaft 2.

~~In Fig. 11, the reference numeral 17 denotes a gearbox for a transmission shaft~~ **[A gearbox 17 for a transmission shaft is shown in Fig. 11]**. A transmission shaft 21 is rotatably supported ~~via~~ **[in]** bearings 18 and 19 within the gearbox 17, and is connected to a motor (not ~~show).~~ **[shown).]** A gear 22 is mounted on the transmission shaft ~~21.~~ **[21.]** In the gearbox 13 for **[the]** drive shaft, gears 23a and 23b **[are mounted]** for transmitting rotation ~~for driving~~ **[to drive]** a pair of rotor drive shafts 12A and 12B in mutually opposite ~~direction~~ **[directions]** in synchronism with each other and a gear 23c **[is provided]** meshing with the gear 22 mounted on the transmission shaft 21 ~~are provided~~.

Accordingly, a driving force of the motor to be transmitted to the transmission shaft 21 is transmitted to one rotor shaft 12A ~~via~~ **[through]** the gears 22 and ~~23c.~~ **[23c.]** The driving force of the rotor drive shaft 12A is transmitted to the other rotor drive shaft 12B ~~via~~ **[through]** the gears 23a and 23b.

For assembling the rotary pump constructed as set forth above, the pumping segment 4 of each rotor 1A and 1B is received within the pumping chamber 7 of the main casing ~~10.~~ **[10.]** In conjunction therewith, each rotor shaft 2 is engaged with the hollow portion 16a at the tip end of the hollow rotor drive shaft 12 supported within the gearbox ~~13.~~ **[13.]** Then, the rotor fastening bolt 15 is inserted within the rotor drive shaft 12 from one end to threadingly engage the threaded portion 15b at the tip end thereof with the threaded bore 3 of the rotor shaft ~~2.~~ **[2.]** Then, the bolt head 15a is rotated by a rotary tool, such as spanner or the like for tightening to draw each rotor 1A and 1B toward the rotor drive shaft 12 for ~~fixedly~~ **[fixed]** fastening.

In the rotary pump assembled as set forth above, a rotational torque of the not shown motor is transmitted to the transmission shaft \21.\ **[21.]** Both of the rotor drive shafts 12 driven to rotate \via\ **[through]** the transmission shaft 21 drive to rotate both rotors 1A and 1B in mutually opposite directions in synchronism with respect to each other as shown by arrows in Fig. \11.\ **[11.]** Thus, by action of the pumping segments 4 rotated within the pumping chambers 7, liquid is sucked into the pumping chamber 7 through the suction port 8 and is pressurized and fed to the discharge port 9. In this case, overall inner side surface of the casing cover 11 is a flat surface \forming\ in flush with the external end surface of the rotors 1A and 1B \so as\ not to form **[a]** recessed portion between the rotors 1A and \1B.\ **[1B.]** Therefore, **[there will be no]** retention of the transported liquid flowing through the pumping chamber 7 \will never be caused\. Accordingly, washing of the pumping chamber can be easily performed.

On the other hand, upon disassembling the rotors 1A and 1B, \the\ nuts 20 are \loosen\ **[loosened]** to remove the casing cover 11, and thereafter, the rotors 1A and 1B are **[easily]** disassembled \easily\ by simply loosening the rotor fastening bolts 15.

As \can be\ **[is]** clear from the construction, in the prior art, the gearbox \16\ [17] for the transmission shaft 21 is provided separately from the gearbox 13 of the drive shaft, and driving force has to be transmitted to the rotor drive shaft 12 \via\ **[through]** the gear mounted on the transmission shaft 21 on the side of the motor and the gear 23a housed within the gearbox 13 for the drive shaft.

Conventionally, **[there are required]** in addition to a pair of rotor drive shafts 12A and 12B for driving the rotor as set forth above, the transmission shaft 21 for transmitting the rotational torque of the motor to the rotor drive shafts 12A and 12B, \and thus\ **[a total of]** at least three \shaft\ **[shafts]** in total \are required.\ **[.]** Therefore, the construction is inherently complicate.

On the other hand, as can be clear from the construction set forth above, in the recent prior art, the rotor fastening bolt 15 inserted into the hollow portion of the hollow rotor drive shaft 12 is rotated by rotating the bolt head 15 at the rear end \portion\ with the rotary tool \in the condition where\ **[so that]** the threaded portion 15b at the tip \end\ is threadingly engaged with the rotor 1A (1B) to draw the rotor 1A backward by the

rotor fastening bolt 15 and to abut the bolt head 15a onto the end surface of the hollow rotor drive shaft ~~\12.\~~ **[12.]** On the other hand, upon ~~\disassembling\~~ **[disassembly]**, the rotors 1A and 1B can be disassembled easily only by loosening the rotor fastening bolt 15 by rotatingly operating the bolt head ~~\15a.\~~ **[15a.]** Also, the mating surfaces of the rotor 1A(1B) and opposing casing cover 11 may be formed ~~\in flush.\~~ **[flush.]** Coupling between the rotor 1A(1B) and the hollow rotor drive shaft 12A(12B) is effected by externally engaging the tip end ~~\portion\~~ of the drive shaft and by maintaining external engagement by drawing force applied by tightening the rotor fastening bolt 15 into the rotor shaft ~~\12.\~~ **[12.]** Therefore, **[the force of the]** connection ~~\force therebetween is insufficient.\~~ **[between them is insufficient.]** Also, centering of the rotor 1A(1B) and the hollow rotor drive shaft 12A(12B) cannot be complete **[thereby]** to ~~\possibly\~~ cause **[possible]** center vibration.

Furthermore, as shown in Figs. 10 and 11, the ~~\conventionally\~~ **[conventional]** rotary pump defines the pumping chamber 7 with the main casing 10 and the casing cover 11 mounted ~~\thereon.\~~ **[thereon.]** A pair of rotors 1A and 1B are housed within the pumping chamber ~~\7.\~~ **[7.]** The end surface 1a of the casing cover 11 of each of rotors 1A and 1B are placed in substantially contacting state with a minimum fine gap required for permitting rotation of the ~~\rotor\~~ **[rotors]** 1A and ~~\1B.\~~ **[1B.]** Both rotors 1A and 1B are synchronously rotated in mutually opposite directions by mutually engaging the pumping segments 4 of the rotors 1A and 1B by the rotor drive shafts 12 as shown by the arrows of Fig. ~~\11.\~~ **[11.]** Thus, the liquid is sucked into the pumping chamber 7 through the suction port 8, and pressurized and fed to the discharge port ~~\9.\~~ **[9.]** In this case, a gap between the end surface 1a of each rotor 1A and 1B and the inner ~~\end\~~ surface 11a of the casing cover 11 mating thereto ~~\is\~~ **[are]** substantially ~~\contacting state\~~ **[in contact]** with ~~\minimum\~~ **[a minimal]** fine gap for permitting rotation of the rotor 1A and ~~\1B. Flow\~~ **[1B. The]** ability **[to flow]** of the liquid in this fine gap is quite ~~\low.\~~ **[low.]** Accordingly, even when ~~\the\~~ washing liquid is circulated within the pumping chamber at the end of ~~\work in one day\~~ **[workday]**, the washing liquid does not flow sufficiently between both ~~\end\~~ surfaces 11a and ~~\1a.\~~ **[1a.]** Therefore, **[a]** sufficient washing effect cannot be achieved.

~~\SUMMARY OF THE INVENTION\~~ **[Summary of the invention]**

The present invention has been ~~\worked out\~~ **[developed]** in view of the problems set forth ~~\above.\~~**[above.]** Therefore, it is the first object of the present invention to construct a rotary pump with simple construction by omitting a transmission shaft on the side of a motor and ~~\whereby\~~ **[thereby]** to make a cost of the rotary pump as low as possible, ~~\with\~~ **[while]** maintaining ~~\feature that\~~ **[ease of]** assembling and disassembling ~~\is facilitated.\~~**[.]**

~~\The second objection\~~ **[Another object]** of the present invention is to enhance **[the]** fastening force between the rotary drive shaft and the rotor and assure centering therebetween ~~\so as\~~ not to cause center vibration even ~~\by\~~ **[under]** long term use.

~~\The third\~~ **[Yet another]** object of the present invention is to achieve satisfactory washing effect by flowing sufficient amount of washing liquid through a gap between an end surface of a rotor and an inner end surface of a casing cover opposing thereto.

According to ~~\the\~~ **[a]** first aspect of the present invention, ~~\a\~~ **[the]** rotary pump comprises:

a pair of ~~\rotors\~~**[rotors]** having pumping ~~\segments\~~**[segments]** mutually engaged with each other for synchronous revolution in mutually opposite ~~\direction\~~ **[directions]** within a pump casing;

a pair of ~~\hollowing\~~ **[hollow]** rotor drive ~~\shafts\~~**[shafts]** supported in ~~\gearboxes\~~**[gearboxes]** adjacent the pump ~~\casing\~~**[casing]** for ~~\integrally rotate\~~ **[integral rotation]** with ~~\a\~~ **[said]** pair of ~~\the\~~ rotors; and

a pair of rotor fastening ~~\bolts\~~**[bolts]** inserted into hollow ~~\portions\~~**[portions]** of respective hollow rotor drive ~~\shafts\~~**[shafts]** to ~~\fix\~~ **[attach]** the pair of ~~\rotors\~~**[rotors]** and the pair of hollow rotor drive ~~\shafts\~~**[shafts]** on the outer end surfaces of the rotor drive ~~\shaft\~~**[shaft]** under tension~~\~~**[.]**

Respective **[ones]** of the hollow rotor drive ~~\shafts\~~**[shafts]** being synchronously rotated in mutually opposite direction with meshing with synchronous driving gears provided in respective gearboxes, ~~\~~

~~Among both of the hollow rotor drive shafts,~~ one of the hollow rotor drive shaft extends outwardly from the gearbox to form an extended drive shaft portion, a cylindrical frame ~~form~~ **[shaped]** transmission ~~coupling~~ **[coupling]** having an ~~operation space~~ **[operating space]** for operating the rotor fastening ~~bolt~~ **[bolt]** being coupled with the extended drive shaft ~~portion~~ **[portion]** for integral rotation.

According to ~~the~~ **[a]** second aspect of the present invention ~~a~~ **[the]** rotary pump comprises:

a pair of ~~rotors~~ **[rotors]** having pumping ~~segments~~ **[segments]** mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of ~~hollowing~~ **[hollow]** rotor drive ~~shafts~~ **[shafts]** supported in ~~gearboxes~~ **[gearboxes]** adjacent the pump ~~casing~~ **[casing]** for ~~integrally rotate~~ **[integral rotation]** with a pair of the rotors; and

a pair of rotor fastening ~~bolts~~ **[bolts]** inserted into hollow ~~portions~~ **[portions]** of respective hollow rotor drive ~~shafts~~ **[shafts]** to fix the pair of ~~rotors~~ **[rotors]** and the pair of hollow rotor drive ~~shafts~~ **[shafts]** on the outer end surfaces of the rotor drive ~~shaft~~ **[shaft]** under tension, ~~,~~

~~respective [ones] of the hollow rotor drive shafts [shafts] being synchronously rotated in~~ mutually opposite direction ~~with~~ **[and]** meshing with synchronous driving ~~gears~~ **[gears]** provided in respective gearboxes, ~~,~~

~~the rotors~~ **[rotors]** and the hollow rotor drive ~~shafts~~ **[shafts]** being connected by ~~spline couplings~~ **[splined couplings]** for integral rotation, ~~,~~

~~the~~ rotor fastening ~~bolts~~ **[bolts]** being inserted through the hollow rotor drive ~~shafts~~ **[shafts]** through the ~~rotors~~ **[rotors]** from the side of the casing cover, and ~~,~~

~~a~~ ~~flange~~ **[flange]** provided on a end portion of the rotor fastening ~~bolt~~ **[bolt]** being engaged within a recessed ~~portion~~ **[portion]** on the end surface of the ~~rotor~~ **[rotor]** on the side of the casing cover.

According to ~~the~~ **[a]** third aspect of the present invention, ~~a~~ **[the]** rotary pump comprises:

a pair of ~~\rotors_\~~**[rotors]** having pumping ~~\segments_\~~**[segments]** mutually engaged with each other for synchronous revolution in mutually opposite direction within a pump casing;

a pair of ~~\hollowing\~~ **[hollow]** rotor drive ~~\shafts_\~~**[shafts]** supported in ~~\gearboxes_\~~**[gearboxes]** adjacent the pump ~~\casing_\~~**[casing]** for ~~\integrally rotate\~~ **[integral rotation]** with a pair of the rotors; and

a pair of rotor fastening ~~\bolts_\~~**[bolts]** inserted into hollow ~~\portions_\~~**[portions]** of respective hollow rotor drive ~~\shafts_\~~**[shafts]** to fix the pair of ~~\rotors_\~~**[rotors]** and the pair of hollow rotor drive ~~\shafts_\~~**[shafts]** on the outer end surfaces of the rotor drive ~~\shaft_\~~**[shaft]** under tension, ~~\~~

~~\~~respective of the hollow rotor drive ~~\shafts_\~~**[shafts]** being synchronously rotated in mutually opposite direction ~~\with\~~ **[and]** meshing with synchronous driving ~~\gears_\~~**[gears]** provided in ~~\respective\~~ **[respec**

tive] gearboxes, ~~\~~

~~\~~the ~~\rotor_\~~**[rotor]** and the hollow rotor drive ~~\shaft_\~~**[shaft]** being connected by ~~\spline coupling_\~~**[splined coupling]** for integral rotation, ~~\~~

~~\~~the rotor fastening ~~\bolts_\~~**[bolts]** being integrally formed with the rotors, and ~~\~~

~~\~~the rotor fastening ~~\bolts_\~~**[bolts]** being inserted into the hollow rotor driven shafts.

According to ~~\the\~~ **[a]** fourth aspect of the present invention, ~~\a\~~ **[the]** rotary pump comprises:

~~_\~~a main casing;

~~_\~~a casing cover ~~\cooperated\~~ **[cooperating]** with the main ~~\casing_\~~**[casing]** for defining a pumping

~~\chamber_\~~**[chamber]** therebetween;

~~\~~

~~_\~~a pair of ~~\rotors_received within\~~ **[rotors in]** the pumping ~~\chamber_\~~**[chamber]** with mutually meshing pumping ~~\segments_\~~**[segments]** for synchronous revolution in mutually opposite directions;

~~_a space_being defined\~~ **[a space]** in one portion of the casing cover;

_\a cover \~~piston_being~~\ **[piston]** disposed within the space for movement back and forth with respect to an end surface of the rotor;

\an air \~~cylinder~~**[cylinder]** being mounted on the casing cover and having a piston rod, to which the cover piston is connected.

According to \~~the~~\ **[a]** fifth aspect of the present invention, \~~a~~\ **[the]** rotary pump comprises:

_\a main casing;

\a casing cover \~~cooperated~~\ **[cooperating]** with the main \~~casing~~**[casing]** for defining a pumping

\~~chamber_~~**[chamber]** therebetween;

\

_\a pair of \~~rotors_received within~~\ **[rotors in]** the pumping \~~chamber_~~**[chamber]** with mutually meshing pumping \~~segments_~~**[segments]** for synchronous revolution in mutually opposite directions;

\a \~~space~~**[space]** being defined in one portion of the casing cover; \

\a cover \~~piston~~**[piston]** being disposed within the space for movement back and forth with respect to an end surface of the rotor; \

\a lock \~~cylinder~~**[cylinder]** having a lock \~~bolt_~~**[bolt]** being mounted on the casing cover for restricting movement of the cover \~~piston_~~**[piston]** by means of the lock bolt.

According to \~~the~~\ [a] fifth aspect of the present invention, \~~a~~\ [the] rotary pump comprises:

_\a main casing;

\a casing cover \~~cooperated~~\ **[cooperating]** with the main \~~casing~~**[casing]** for defining a pumping

\~~chamber_~~**[chamber]** therebetween;

\

_\a pair of \~~rotors_received within~~\ **[rotors in]** the pumping \~~chamber_~~**[chamber]** with mutually meshing pumping \~~segments_~~**[segments]** for synchronous revolution in mutually opposite directions;

\~~_a space_being defined~~\ **[a space]** in one portion of the casing cover; \

_\a cover \~~piston_being disposed within~~\ **[piston in]** the space for movement back and forth with respect to an end surface of the rotor; \

_\an air \~~cylinder_being~~\ **[cylinder]** mounted on the casing cover and having a piston rod;
\

\a lock \~~cylinder~~**[cylinder]** having a lock \~~bolt_~~**[bolt]** being mounted on the air cylinder; \

\the cover piston being connected to a piston rod projected from one end surface of the \~~piston~~**[piston]** of the air cylinder; \

\a piston rod projecting from the other end surface of the \~~piston~~**[piston]** of the air \~~cylinder_being~~\ **[cylinder]** abutted to the lock bolt for restricting movement of the cover \~~piston_~~**[piston]** by means of the lock bolt.

According to \~~the~~\ **[a]** sixth aspect of the present invention, \~~a~~\ **[the]** rotary pump comprises:

_\a main casing;

_\a casing cover \~~cooperated~~\ **[cooperating]** with the main \~~casing_for~~\ **[casing and]** defining a pumping \~~chamber_~~**[chamber]** therebetween;

\

\a pair of \~~rotors~~**[rotors]** received within the pumping \~~chamber_~~**[chamber]** with mutually meshing pumping \~~segments_~~**[segments]** for synchronous revolution in mutually opposite directions;

_\~~a space_being defined~~\ **[a space]** in one portion of the casing cover;

_\a cover \~~piston_being disposed within~~\ **[piston in]** the space for movement back and forth with respect to an end surface of the rotor;

_\a plurality of air \~~cylinders_being~~\ **[cylinders]** mounted on the casing cover \~~in a condition where~~\ **[wherein]** piston \~~rods_~~**[rods]** thereof are connected with each other, and the cover piston is connected to a piston rod\~

\ and having a piston rod, to which the cover piston is connected.

According to \~~the~~\ **[a]** seventh aspect of the present invention, \~~a~~\ **[the]** rotary pump comprises:

_\a main casing;

_\a casing cover \~~cooperated~~\ **[cooperating]** with the main \~~casing_for~~\ **[casing and]** defining a pumping \~~chamber_~~**[chamber]** therebetween;

\

~~\~~a pair of ~~\rotors~~ received~~\~~ **[rotors]** within the pumping ~~\chamber~~**[chamber]** with mutually meshing pumping ~~\segments~~**[segments]** for synchronous revolution in mutually opposite directions;

~~\~~ a space~~ being defined\~~ **[a space]** in one portion of the casing cover;

~~\~~\a cover ~~\piston~~ being disposed within~~\~~ **[piston in]** the space for movement back and forth with respect **[**

]to an end surface of the rotor;

~~\~~\a plurality of air ~~\cylinders~~ being~~\~~ **[cylinders]** mounted on the casing cover ~~\in a condition where\~~ **[wherein]** piston ~~\rods~~**[rods]** thereof are connected with each other, and the cover piston is connected to a piston rod~~\~~

~~\~~ and having a piston rod, to which the cover piston is connected;

~~\~~\a lock bolt ~~\being\~~ coaxially provided on the air cylinder at the rearmost position, and the cover piston being connected to the piston ~~\rod~~**[rod]** of the air ~~\cylinder~~ at the most ~~\~~**[cylinder at its]** front **[most]** side;

~~\~~\a ~~\piston~~**[piston]** or a piston rod of the air cylinder at the rearmost position being in contact with the lock bolt for restricting movement of the cover piston by the lock bolt.

~~\BRIEF DESCRIPTION OF THE DRAWINGS\~~ [Brief description of the drawings]

The present invention will be understood more fully from the detailed description given hereinafter with reference to the accompanying ~~\drawings of the preferred\~~ [drawing of a suitable] embodiment of the present invention, which, however, should not be taken to be limitative to the present invention, but ~~\are\~~ **[is]** for explanation and understanding only.

In the drawings:

Fig. 1 is a ~~\partially sectioned\~~ front elevation **[in partial cross-section]** of one embodiment of a rotary pump according to the present invention;

Fig. 2 is a perspective view of the major part of the first embodiment of the rotary pump;

Fig. 3 is a ~~\longitudinally sectioned front elevation\~~ **[front view in longitudinal cross-section]** of another major part of the first embodiment of the rotary pump;

Fig. 4 is a ~~\longitudinally sectioned front elevation\~~ **[front view in longitudinal section]** of another embodiment of the portion shown in Fig. 3;

Fig. 5 is a ~~\partially sectioned front elevation\~~ **[front view in partial cross-section]** of another embodiment of the rotor according to the present invention;

Fig. 6 is a ~~\partially sectioned front elevation of slightly\~~ **[front view in partial cross-section of slight]** modification of the embodiment shown in Fig. 5;

Fig. 7 is a ~~\longitudinally sectioned front elevation\~~ **[front view in cross-section]** showing operating condition of the major part of the embodiment shown in Fig. 5;

Fig. 8 is a ~~\longitudinally sectioned front elevation showing \~~**[front view in longitudinal cross-section showing the]** operating condition of the major part of the embodiment shown in Fig. 6;

Fig. 9 is a ~~\longitudinally sectioned front elevation showing \~~**[front view in longitudinal cross-section showing the]** operating condition of the major part of another embodiment shown in Fig. 6;

Fig. 10 ~~\is a partially sectioned front elevation\~~**[(prior art) is a front view in partial cross-section]** of the conventional rotary pump; and

Fig. 11 ~~\is a side elevation of an internal mechanism.\~~**[(prior art) is a side elevational view of a conventional internal pump mechanism.]**

~~\DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT~~

~~The present invention will be discussed hereinafter in detail in terms of the preferred embodiment of the present invention with reference to the accompanying drawings.~~ **\[Detailed description]**

In the following description, numerous specific details are set forth ~~in order\~~ to provide a thorough understanding of the present ~~\invention.~~ **\[invention.]** It will be ~~\obvious\~~ **[clear]**, however, to those skilled in the art that the present invention ~~\may\~~ **[can]** be practiced without **[many of]** these specific ~~\details.~~ **\[details.]** In other ~~\instance\~~ **[instances]**, well-known ~~\structure\~~ **[structural components]** are not shown in detail ~~\in order to avoid unnecessary obscurity of the present invention.\~~ **[to avoid unnecessarily complicating the description.]**

Fig. 1 shows one embodiment of a rotary pump according to the present ~~\invention. A\~~ **[invention. The]** construction of the rotary pump is basically ~~\the same as\~~ **[very similar to]** the prior art shown in Figs. 10 and ~~\11.~~ **\[11.]** Namely, a pump casing 30 is constructed with a main casing 43 which define a concave pumping chamber 42 one the side of one ~~\end\~~ surface for housing a pair of rotors 31A and 31B ~~\(which will be\~~**[(the**

rotors generally] identified by the reference numeral 31 ~~\as generally referred to) and\~~**[) which]** loosely engage with pumping segments 32 ~~\which are\~~ integrally formed with the rotors 31A and 31B for rotation ~~\therein, and\~~ **[therewith; the casing 30]** also defines a suction port 50 and a discharge port 51 ~~\communicated\~~ **[communicating]** with the pumping chamber 42, and a casing cover 44 detachably mounted on the main casing 43 by bolts 52 ~~\in\~~ flush with the end surface of ~~\a\~~ **[the]** pair of rotors 31.

~~\It\~~ **[This embodiment]** is similar to the prior art in that a pair of rotors 31 are mounted on hollow rotary drive shafts 34A and 34B (which ~~\will be identified by \~~**[are referred to generally by the]** reference numeral 34 ~~\as generally referred to)\~~**[)]** by tightening **[a]** rotor fastening bolt 36 into hollow portions 35 of the rotary drive shafts 34. However, **[the]** particular mounting structure is ~~\differentiated\~~ **[different]** from the prior ~~\art._\~~**[art.]** As shown in Fig. 3, in accordance with the present invention, a through opening 53 formed with an internal **[outer]** peripheral surface 46 with **[a]** spline groove and a recessed portion 48 ~~\communicated\~~ **[communicating]** with the through opening 53, having greater diameter that the through opening 53 and **[an]** opening on the side of the casing cover 44 are **[respectively]** formed in the rotors 31~~\, respectively._\~~**[.]** Tip ends of a pair of hollow rotor drive shafts are formed as ~~\spline\~~ **[splined]** shafts 45 engaging ~~\with\~~ the spline of the inner periphery 46 of the through opening 53 so that the rotors 31 and the hollow rotary drive shafts 34 are integrated for rotation in accurately and coaxially aligned ~~\condition\~~ **[manner]** by engaging the ~~\spline\~~ **[splined]** shafts 45 with the through openings 53.

~~\Then, the\~~ **[The]** rotor fastening bolt 36 **[is]** integrally formed with **[a]** flange portion 47 which engages with the recessed portion 48 formed in the rotor 31~~\,\~~**[. The bolt]** is inserted from the side of the casing cover ~~\44._\~~**[44.]** The rotor fastening bolt 36 is then inserted into the hollow portion 35 of the hollow rotor drive shaft 34 to extend a tip end thereof from an outer end surface of the hollow rotor drive shaft ~~\to be exposed therefrom._\~~**[and to range outwardly therefrom.]** A fastening nut 49 is engaged with the ~~\exposed\~~ **[outward ranging]** tip ~~\end\~~ of the rotor fastening bolt ~~\36._\~~**[36.]** By tightening the fastening nut 49 onto the rotor fastening bolt 36, the rotor 31 is drawn toward the hollow rotor drive shaft 34 to be fixed in a condition firmly abutting ~~\onto\~~ **[against]** an inner end surface at a tip ~~\end\~~ of the hollow rotor drive shaft ~~\34._\~~**[34.]** It should be noted that in the condition where ~~\the\~~ **[a]** flange 47 **[is]** received within ~~\the\~~ **[a]** recessed portion

48, the flange 47 and the rotor 31 form a flush surface mating with the casing cover \44.\ **[44.]** The fastening nut 49 \may\ **[can]** be replaced with a washer to engage the washer with the rotor fastening bolt 36 and a lock nut 57 is employed as the fastening nut so that the fastening nut 57 is engaged and tightened with the rotor fastening bolt 36 \via\ **[through]** the washer to achieve \the\ **[a]** similar effect\, as a matter of course.\ **[.]** In the alternative, a sealing member 72 such as an O ring is disposed between the flange portion 47 and the recessed portion 48 , and in conjunction therewith, the flange 47 and the rotor 31 form the flash surface to be mated with casing cover 44 in the condition where the flange 47 is engaged with the recessed portion 48, as shown in Fig. \3. In the drawings, the reference numerals 73 and 74 denote mechanical seals for maintaining **[3. Mechanical seals 73 and 74 are provided for maintaining a liquid tight state]** between the pump chamber 42 and the outside \in liquid tight state\.

On the other hand, in the embodiment shown in Fig. 3, the rotor fastening bolt 36 is provided with the \foregoing\ flange portion 47 on the tip \end\ portion thereof to engage with the recessed portion 48 \provided\ in the rotor \31.\ **[31.]** However, it is also possible to form the rotor fastening bolt 36 integrally with the rotor 31 to extend axially as shown in Fig. \4.\ **[4.]** With the embodiment shown in Fig. 4, since number of the parts can be reduced in comparison with the embodiment shown in Fig. 3, assembling can be \facilitated.\ **[facilitated.]** Furthermore, since the modification reduces \portion to possibly retain the liquid to be further\ **[possibility of retention of liquid, it is also more]** sanitary.

A pair of the hollow rotor drive shafts 34 (34A and 34B) are supported by bearings 55 and 56 in a gearbox 33 \(housing 54) which is\ **[in a housing 54]** located adjacent the pump casing \30. Also, within\ **[30. Within]** the gearbox 33, gears 37 \and**[,]** 37 **[are provided]** for synchronous driving \are provided\ for respective **[one]** of the hollow rotor drive shafts 34 so that the hollow rotor drive shafts 34A and 34B are synchronously driven for rotation in mutually opposite directions.

\Among the foregoing hollow rotor drive shafts 34 (34A and 34B), one\ **[One]** hollow rotor drive shaft 34A is extended from the gearbox 33 \in\ **[to a]** greater extent to form an extended drive shaft portion \39. On the extended drive shaft portion 39, a\ **[39. A]** cylindrical frame shaped transmission coupling \42 which is **[41 is connected**

on the so extended drive shaft portion 39. This is an] important feature of the present invention\~~, is connected.~~**[.]**

~~\Namely, as\~~ **[As]** shown in Fig. 2, ~~\the\~~ **[a]** transmission coupling ~~\42\~~ **[41]** is formed with a cylindrical frame shaped coupling body 59 having a large operation window 58 on ~~\the\~~ **[its]** circumference ~~\thereof\~~, a boss hole **[60]** projected on one end surface for connection, a connecting frame 62 for connecting a coupling 61 on the side of the other end portion of the transmission member, an operation window 63 and a connecting hole ~~\64.~~**[64.]** After ~~\appropriately\~~ fitting a collar 65 to the extended drive shaft ~~\portion\~~ 39, the extended drive shaft 39 is engaged with the connecting boss hole 60 of the transmission coupling 41 to establish a key coupling with a key groove 66 and a key 67 provided between the extended drive shaft 39 and the transmission coupling ~~\41.~~ ~~Furthermore,\~~ **[41. A connecting nut 68 is engaged and tightened]** on a threaded portion 39a ~~\provided\~~ on the outer periphery of the extended drive shaft 39, ~~\a connecting nut 68 is engaged and tightened\~~ for coupling the extended drive shaft portion 39, and namely the hollow rotor drive shaft 34 with the transmission coupling 41 for integral ~~\rotation.~~**[rotation.]** On the other hand, a transmission member 69 connected on the side of the motor is connected to the transmission coupling 41 ~~\via\~~ **[through]** the coupling on the side of the transmission member by **[a]** bolt and nut 70, **[with]** the connecting hole 64 of the connecting frame 62 **[being]** engaged with the bolt and nut 70 and a buffering connecting member 71 engaged with the connecting hole ~~\64.~~**[64.]** As ~~\can be\~~ **[it becomes]** clear from the ~~\discussion given hereabove, the\~~ foregoing [description, the] fastening nut 49 and the lock nut 57 are **[normally]** tightened with the rotor fastening ~~\body\~~ **[bolt]** 36 after mounting the transmission coupling 41~~\, as a matter of course\~~.

Upon driving the rotary pump ~~\constructed as set forth above, a\~~ **[of the present invention, the]** rotational force of the transmission member 69 connected on the side of the motor is transmitted to the transmission coupling 41 ~~\via the\~~ **[through a]** coupling 61 on the side of the transmission ~~\member.~~**[member.]** The **[transmission]** coupling 41 drives the hollow rotor drive shaft 34A on one ~~\side\~~ **[end]** which is connected directly to the coupling 41, and drives the other hollow rotor drive shaft 34B ~~\via\~~ **[through]** a pair of synchronous driving gears 37 and ~~\38.~~**[38.]** By this, ~~\a\~~ **[the]** pair of rotors 31 are synchronously rotated in mutually opposite directions.

~~\During rotation of the rotors, since\~~ **[Since]** the main casing 43 and the casing cover 44 are firmly fitted with each other in face-to-face contact, **[during rotation of the rotors]** the transported liquid may not be retained in this portion to keep the rotary motor in sanitary ~~\state.\~~**[state.]** Upon ~~\disassembling\~~ **[disassembly]**, in the condition where the transmission coupling 41 is mounted on the hollow rotor drive shaft 34, an operator ~~\may\~~ **[can]** insert a rotary tool, such as spanner, screw driver or the like into an operation space 40 through the ~~\operation\~~ **[operating]** window 58 or 63 to easily disengage the fastening nut 49 and the lock nut 57 which are engaged with the rotor fastening bolt 36 within the operation space ~~\40.\~~**[40.]** Then, by loosening the ~~\bolt and nut 20\~~ **[bolts 52]**, the casing cover 44 is disassembled from the main casing ~~\43.\~~**[43.]** Thus, the rotor 31 and the rotor fastening bolt 36 as assembled or integrated as in the embodiment shown in Fig. 4 ~~\may\~~ **[can]** be withdrawn to the outside of the main casing ~~\43.\~~**[43.]** Therefore, the pumping chamber 42 can be easily disassembled for performing cleaning operation.

Upon assembling, the rotor drive shaft 34 is inserted into the through opening 53 in such a manner that the ~~\spline\~~ **[splined coupling]** shaft 45 of the rotor drive shaft 34 is engaged with spline surface of the rotor ~~\31.\~~**[31.]** The rotor fastening bolt 36 is then inserted into the hollow portion 35 of the hollow rotor drive shaft 34 from the side of the casing cover ~~\44.\~~**[44.]** At the rear end ~~\portion\~~, the operator tightens the fastening nut (washer) 49 and the lock nut 57 (fastening nut) onto the rotor fastening bolt 36 within the operation space 40 through the operation window 58 or ~~\63.\~~[63.] Thus, the rotary pump can be easily assembled.

With the foregoing embodiment, the ~~\spline\~~ **[splined coupling]** shaft 45 at the tip end portion of the hollow rotor drive shaft is engaged with the spline surface on the inner periphery of the through opening 53 of the rotor 31, and the hollow rotor drive shaft 34 and the rotor 31 are rigidly secured with each other by the rotor fastening bolt ~~\36.\~~**[36.]** Therefore, **[no]** slip will ~~\never be caused\~~ **[occur]** therebetween**[, thus]** to assure integral ~~\rotation.\~~**[rotation.]** Furthermore, concentric relationship between the rotor and the hollow rotor drive shaft can be maintained for a long period.

Figs. 5 to 9 show another embodiment of the rotary pump according to the present ~~\invention.\~~**[invention.]** It should be noted that, in the following disclosure,

components common to the former embodiment of Figs. 1 to 4, will be identified by the same reference numerals, and detailed discussion for such common components will be omitted in order to avoid redundant discussion and whereby to keep the disclosure simple enough to facilitate clear understanding of the present ~~\invention._\~~**[invention.]** Therefore, the following disclosure will be concentrated to the particular construction of the ~~\shown\~~ **[illustrated]** embodiment.

As shown in Fig. 5, a space 80 having a given width in a thickness direction of a casing cover 44A is defined at the center portion of the casing cover 44A with the end surface 31a of the rotor 31 by forming a recess on the surface of the casing cover 44A mating with the end surface 31a of the rotor ~~\31._\~~**[31.]** A cover piston 81 is engaged with the peripheral wall defining the space 80 in gas tight fashion for reciprocal motion in the thickness direction, namely toward and away from the end surface 31a of the rotor ~~\31._\~~**[31.]** An air cylinder 82 is mounted on the casing cover 44A in coaxial relationship with the cover piston 81 by mounting bolts ~~\83._\~~**[83.]** The air cylinder 82 is constructed with a cylinder body 82a, a cylinder cover 86 located on the side of the casing cover 44A, a cylinder cover 87 on the opposite side, a piston 88 slidingly reciprocating within the cylinder body 82a, a piston rods 83a and 83b (which will be identified by reference numeral 83 as generally referred to) extending from both sides of the piston 88, and inlet and outlet ~~\ports_\~~**[ports 91]** and 92 communicated with forward drive side and reverse drive side cylinder chambers 89 and 90 defined on both sides of the piston ~~\88._\~~**[88.]** The cylinder cover 86 on the side of the casing cover 44A may be formed to be common with the casing cover ~~\44A._\~~**[44A.]** Also, the cylinder cover 86 ~~\may\~~ **[can]** be provided separately on the side of the air cylinder ~~\82._\~~**[82.]** In this case, the space 80 of the casing cover 44A is formed through the casing cover ~~\44A._\~~**[44A.]** On the other hand, the cylinder cover 86 formed separately on the side of the air cylinder 82 ~~\may\~~ **[can]** serve as the casing cover 44A and the cylinder cover 86 ~~\ands\~~ **[and]** the casing cover ~~\may\~~ **[can]** be formed integrally with each ~~\other._\~~**[other.]** In this case, the cylinder cover 86 of the air cylinder is mounted directly on the main casing 43 as the casing cover 44A by the bolts.

The end surface 81a on the side of the rotor 31 of the cover piston ~~\8\~~ **[81]** is mated with the inner end surface 44a of the casing cover 44A for ~~\tight\~~ **[tightly]** fitting with each ~~\other._\~~**[other.]** On the other hand, the end surface 81a of the rotor 31 is substantially in contact with the end surface 31a of the rotor 31 with maintaining a fine gap

~~\therebetween.\~~**[therebetween.]** The piston rod 83a extended from the piston 88 of the air cylinder 82 toward the casing cover 44A is integrally connected to the cover piston 81 through the cylinder cover ~~\86.\~~**[86.]** The piston rod 83b projecting from the piston toward the opposite side is extended externally through the other cylinder cover ~~\87.\~~**[87.]** More accurately, the piston rod 83b is formed with a collar 94 engaging ~~\with\~~ a small diameter portion 93 and a nut 95 threadingly engaged with a ~~\thread\~~ **[threaded]** portion at the tip end of the small diameter portion in order to secure the collar 94.

~~\To the air cylinder 82, a\~~ **[A]** lock cylinder 85 is coaxially mounted **[to the air cylinder 82,]** as shown in Fig. ~~\5. To the lock cylinder 83, a\~~ **[5. A]** lock bolt 84 is threadingly engaged~~\, which\~~ **[with the lock cylinder 83. The]** lock bolt may abut against a tip end surface of the piston rod 83b of the air cylinder 82 and is movable back and forth along **[the]** motion direction of the piston rod ~~\83b. On the lock bolt 84, a\~~ **[83b. A]** lock nut 46 is threadingly engaged **[on the lock bolt 84,]** for locking the lock bolt 84 at a predetermined ~~\position.\~~**[position.]** The lock cylinder 85 is not limited to ~~\the\~~ **[a]** cylindrical shape but can be any appropriate ~~\shape. Namely, the\~~ **[shape. The]** lock cylinder is only required to be any appropriate shape of the frame body, to which the lock bolt 84 is threadingly engaged for ~~\linear motion in\~~ **[a]** back and forth ~~\direction.\~~**[linear motion.]** On the other hand, while ~~\the shown\~~ **[this]** embodiment employs the piston rod 83b of the air cylinder to extend outwardly through the cylinder cover 87, it is also possible to engage the lock bolt 84 with the cylinder chamber 89 from the cylinder cover 87 to abut the tip end portion of the lock bolt onto the piston 88 instead of providing the piston rod 83b.

Fig. 6 shows a modification of another embodiment of the rotary pump, in which **[the]** shape of the cover piston 81A **[is]** to be engaged with the space 80 in gas tight ~~\fashion.\~~**[fashion.]** In the embodiment shown in Fig. 5~~\,\~~ **[is]** an end surface 81a at one side of the rotor of the cover piston ~~\81.\~~**[81.]** In contrast to this, the present ~~\invention\~~**[embodiment of the invention as]** shown in Fig. 6 has the cover piston 81A, in which a head portion 99a of the bolt 99 is projected from the rotor ~~\31.\~~**[31.]** Therefore, a recessed portion 100 is provided for, in which a head portion 99a of the bolt 99is projected from the rotor ~~\31.\~~**[31.]** Therefore, a recessed portion 100 is provided for receiving the ~~\heat\~~ **[head]** portion 99a of the bolt ~~\99.\~~**[99.]** In ~~\the shown\~~ **[this]** construction of the rotary pump, a rotor drive shaft 117 is engaged at the center portion of

the rotor 21 for mounting the rotor 31 on the rotor drive shaft ~~\117.\~~**[117.]** Across a stopper plate 101, the bolt 99 is threadingly engaged with the threaded hole 102 provided on the end surface of the rotor drive shaft ~~\117.\~~**[117.]** Thus, the rotor 31 is mounted on the rotor drive shaft.

Except for the shape of the ~~\color\~~ **[cover]** piston 81, the ~~\shown\~~ modification **[of Fig. 6]** has the same construction as the former ~~\embodiment.\~~**[embodiment.]** The common components ~~\has\~~ **[have]** been ~~\omitted\~~**[omitted]** from the detailed discussion ~~\in order\~~ to avoid redundant discussion and ~~\whereby\~~ to keep the disclosure simple enough to facilitate clear understanding of the present invention.

With the construction ~~\set forth above\~~ **[of Fig. 6]**, upon operating the rotary pump in the normal state, as shown in Fig. 5 or 6, an air is supplied into the forward side cylinder chamber 89 through the inlet ~~\port\~~**[port]** of the air cylinder 82 to ~~\whereby\~~ actuate the piston 88 in forward direction, ~~\namely\~~ **[i.e.]** toward left in the ~~\shown case.\~~**[drawing.]** By this, the cover pistons 81 and 81A are placed ~~\in\~~ flush with the inner end surface of the casing cover 44A and substantially in contact with the ~~\pg\ea\~~ **[minimum]** fine gap between the end surface 31a of the rotor ~~\31.\~~**[31.]** It should be noted when the piston 88 is moved toward left in the drawing, air in the left side reverse side cylinder chamber 90 is ~~\discharge out\~~ **[discharged]** through the ~~\discharge\~~ **[outlet]** port 92.

Upon automatic operation by the air cylinder 82, the lock bolt 84 of the lock cylinder 85 is retracted from the tip end surface of the piston rod 83b at the right side of the air cylinder 82 in the ~~\drawing.\~~**[drawing.]** During operation of the rotary pump, the lock bolt 84 of the lock cylinder 85 ~~\may\~~ **[can]** be kept in contact with the tip end surface of the piston rod 83 ~~\so as\~~ to prevent the cover pistons 81 and 81A from being retracted from the end surface 31a of the ~~\piston\~~**[piston]** to reduce pumping effect even when the internal pressure of the pumping chamber 32 is elevated to be higher than or equal to a predetermined pressure to overcome the biasing force of the piston 88 of the air cylinder 82**[.]**

Upon washing the pumping chamber 42 at the end of operation of the pump ~~\in\~~ **[for]** a day, a ~~\griping\~~ **[gripping]** portion of the lock bolt 42 is operated to retract the lock bolt 84from the tip end surface of the piston rod 83 and also, the air is introduced into the reverse side cylinder chamber 90 under pressure and the air in the cylinder chamber 89 on the opposite side is discharged through the ~~\discharge\~~ **[outlet]** port 92, and in conjunction therewith the air in the space 80 defined by the casing cover 44 and the cover piston 81 is discharged through ~~\the\~~ **[an]** air discharge opening ~~\103.\~~**[103.]** By this, as shown in Fig. 7 or Fig. 8, the piston 88 is moved toward right in the ~~\drawing.\~~**[drawing.]** By this, the cover pistons 81 and 81A connected to the piston rod 83a ~~\is\~~ **[are]** retracted away from the end surface 31a of the rotor 31 to define a large gap 104 between the cover piston 81 and 81A and the end surface of the rotor ~~\31.\~~**[31.]** By feeding the washing water into the pumping chamber 42, large amount of the washing water ~~\may\~~ **[will]** flow as shown by arrow and discharged through the discharge port ~~\51.\~~**[51.]** Larger amount and higher flow velocity ~~\may\~~ **[will]** result in higher washing effect to effectively improve **[the]** washing effect for the pumping chamber 42, particularly the end surface 31a of the rotor 31 and the inner end surface 44a of the casing cover 44 ~~\opposing\~~ **[opposed]** to the end surface 31a.

It should be noted that during washing operation, the rotor 31 ~~\may\~~ **[can]** be rotated at low speed or held ~~\stopped.\~~**[stopped.]** The washing water is ~~\preferable\~~ **[preferably]** fed by a dedicated pump for the washing ~~\water.\~~**[water.]** In this case, it is advantageous to make the bypass piping for feeding the washing water unnecessary in the rotary pump.

On the other hand, in case of manual operation, it ~~\may be\~~ **[is]** possible not to use the air cylinder with maintaining the inlet and outlet port in free condition and use only lock cylinder to maintain the cover pistons 81 and 81A in flush with the casing cover 44 by the contact pressure for the piston rod 83b of only **[the]** lock bolt ~~\84.\~~**[84.]** In this case, while the lock cylinder 85 is mounted on the casing cover 44 ~~\via\~~ **[through]** the air cylinder 82, it is also possible to omit the air cylinder to directly secure the lock cylinder 85 onto the casing cover 44 by means of bolts to abut the lock bolt 84 of the lock cylinder 85 to the portion projecting from the casing cover 44 (rod portion 83a).

Then, upon washing, the lock bolt 84 is retracted from the tip end surface of the piston rod ~~\83b.—At\~~ **[83b. In]** this condition, the washing water is fed into the pumping chamber to push the cover piston 81 away from the end surface 31a of the rotor 31 by the water pressure to form the large gap 104 therebetween to effectively flow **[through a]** large amount of washing ~~\waster\~~ **[water]** to improve **[the]** washing effect.

On the other hand, as set forth above, by retracting the lock bolt 84 of the lock cylinder 85 away from the tip end surface of the piston rod 83b on the right side of the air cylinder in the drawing, it becomes possible to provide vented (relief) cover function for the cover pistons 81 and 81A so that the pump discharge pressure of the rotary pump can be adjusted ~~\so as\~~ not to be elevated beyond a given pressure during automatic operation by the air cylinder.

~~\Namely, by\~~ **[By]** constantly supplying a given pressure of air through the inlet port 91 of the air cylinder 82, the cover pistons 81 and 81A are placed in opposition to the pumping action position of the end surface 31a of the rotor 31 by the piston 88 biased by the air ~~\pressure.—\~~**[pressure.]** When the discharge pressure of the pump is elevated beyond the given pressure to build up a pressure to retract the cover pistons 81 and 81A away from the end surface 31a of the rotor 31 **[thus]** overcoming the biasing pressure of the piston 88, the cover piston 81 is retracted from the end surface 31a of the rotor 31 to lower pumping function and ~~\relief\~~ **[relieve]** the discharge ~~\pressure.—By this, the\~~ **[pressure. The]** discharge pressure of the rotary pump can be ~~\regulated.—\~~**[regulated by this.]** The discharge pressure can be freely set by the air pressure to be supplied into the air cylinder.

Fig. 9 shows a further embodiment of the rotary pump according to the present ~~\invention.—\~~**[invention.]** In the former embodiment, only one air cylinder 82 is ~~\provided.—\~~**[provided.]** In contrast to this, the ~~\shown\~~ embodiment **[82A of Fig. 9]** is provided with another air cylinder ~~\82A\~~ mounted by bolts 105, in addition to the air cylinder ~~\82.—\~~**[82.]** Respective pistons 36 and 106 are connected to piston rod 108 extending through a common cylinder cover ~~\107.—\~~**[107.]** The lock bolt 84 is threadingly engaged with the cylinder cover 109 of the later air cylinder ~~\82.—\~~**[82.]** In the ~~\shown\~~ embodiment **[of Fig. 9]**, two air cylinders 82 and 82A are connected with each ~~\other.—\~~**[other.]** However, more than two air cylinders ~~\may\~~ **[can]** be

~~employed.~~ **[employed.]** On the other hand, in the ~~shown~~ embodiment **[82A of Fig. 9]**, the lock bolt 84 is threadingly engaged with the rearmost air cylinder ~~82A. However, it~~**[. It]** is also possible to mount the air cylinder 82A at the rearmost position, to threadingly engage the lock bolt 84 and to contact the lock bolt onto the piston or the piston ~~rod~~ **[rod]** as shown in Figs. 5 and 6.

In the ~~shown~~ embodiment **[82A of Fig. 9]**, by introducing air from an inlet portion 110 of the later air cylinder 82A into the forward ~~side~~ cylinder chamber 111 under pressure, the air is supplied to the forward ~~side~~ cylinder 89 of another air cylinder through a through hole ~~111~~~~2~~ **[112]** provided in the piston rod 108 to push the pistons 88 and 106 of both air cylinders 82 and 82A ~~simultaneously.~~ **[simultaneously.]** Therefore, the cover pistons 81 and 81A are held by both pistons 88 and 106 to maintain the cover pistons 81 and 81A at the position opposing to the pumping action position of the end surface 31a of the rotor 31 at greater ~~force.~~ **[force.]** At this time, as discussed above, the ~~color~~ **[cover]** piston 81 and 81A are held at predetermined action position by the lock bolt 84 as ~~required. The reference numerals 113 and 114 denotes inlet and outlet ports~~ **[required. Inlet and outlet ports 113 and 114]**provided in reverse side cylinder chambers 90 and 115 of both air cylinders 82 ~~and 82A, and the reference numeral 116 may be~~**[, and]**a ventilation aperture **[116 is]** provided in the space 80.

Although the present invention has been illustrated and described with respect to exemplary embodiments thereof, it should be understood by those skilled in the art that the foregoing and various changes, ~~emission~~ **[omission]** and additions ~~may~~ **[can]** be made therein and thereto, without departing from the spirit and scope of the present ~~invention.~~ **[invention.]** Therefore, the present invention should not be understood as limited to the specific embodiment set out above but to include all possible embodiments which can be embodied within a scope encompassed and equivalent thereof with respect to the ~~feature~~ **[features]** set out in the appended claims.